A transorbital approach to the maxillary nerve block in dogs: a cadaver study

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Abstract

Objective To describe a transorbital approach to the maxillary nerve block in dogs and compare it to a traditional one.

Study Design Prospective, randomised controlled study.

Animals Heads from 17 euthanized dogs (10 greyhounds, 3 border collies and 4 mixed breed).

Methods A volume of 1 mL of methylene blue dye was injected by each of two techniques, a traditional percutaneous and a transorbital approach to the maxillary nerve block. Both techniques were used on each head with left and right sides alternating following random assignment to the first head. The heads were dissected to reveal the maxillary nerve and the length of nerve stained was measured.

Results There was no significant difference (p = 0.67) in the proportion of nerves stained greater than 6 mm by either technique (88.2% transorbital, 82.3% percutaneous). The mean length of nerve stained did not differ significantly between the techniques (p = 0.26).

Conclusions and clinical relevance The transorbital approach to the maxillary nerve block described here presents a viable alternative to the traditional percutaneous approach. Further study is required to confirm efficacy and safety under clinical conditions.

Keywords dog, local anaesthesia, maxillary nerve, transorbital approach

Introduction

In small animal patients loco-regional anaesthetic techniques are widely used as a component of multimodal analgesia and balanced anaesthesia protocols. For an effective block to develop, local anaesthetic must be applied to a length of nerve equal to at least 3 nodes of Ranvier, a minimum length of 6 mm (Raymond et al. 1989).

A variety of techniques may be used to perform nerve blocks on the head in small animals and they have been extensively described in the literature (Skarda & Tranquilli 2007; Dugdale 2010; Clarke et al. 2014). Blockade of the maxillary nerve, a sensory branch of the trigeminal nerve, will anaesthetize the nasal planum, upper lip, upper dental arcade, palate and maxilla (Skarda & Tranquilli 2007). The traditional percutaneous approach to the maxillary nerve in dogs was first described in the early twentieth century (Frank 1928). Despite being considered too risky by some earlier authors (Wright 1952), it has firmly found a place in twenty-first century anaesthesia being recommended in major veterinary anaesthesia textbooks (Skarda & Tranquilli 2007; Dugdale 2010; Clarke et al. 2014).

A recent study by Viscasillas et al (2013) compared a modified infraorbital approach to the maxillary nerve, using an intravenous cannula, with the traditional percutaneous approach. The study found that the modified infraorbital approach was more accurate than the percutaneous one, in the hands of inexperienced operators. The authors acknowledged a number of potential risks with their technique, including inadvertent intravascular or intraneural injection and nerve trauma (by direct injury or friction). Despite demonstrating greater accuracy than the traditional approach the success rate of the modified infraorbital technique was 64.9% which presents room for improvement.

The study reported here utilised a transorbital approach to the maxillary nerve block in the dog, in which a needle is passed vertically through the conjunctiva in the rostral orbit lateral to the medial canthus. To the best of the authors' knowledge, it has not been described in the literature or investigated to demonstrate effective delivery of anaesthetic to the nerve. The technique was developed based upon knowledge of the anatomy of the canine head, SDL was introduced to it by a colleague (Pawson 2010, pers. comm.). The transorbital approach has been used regularly by the authors in clinical cases, during dental and maxilliary surgery, with apparent success and without major adverse effects. The advantages of this approach include the reliable placement of the needle at the maxillary foramen, potentially increasing likelihood of block success. In addition, this approach eliminates the risk of nerve trauma caused the cannula that is acknowledged with the modified infraorbital technique of Viscasillas et al (2013).

The aim of the study was to demonstrate that this transorbital technique could successfully deliver an injected solution to the nerve and to compare it with the traditional percutaneous technique in order to assess their relative success at delivery.

Materials and Methods

The heads from 17 canine cadavers donated to the Department of Veterinary Medicine for use in teaching or research following euthanasia were used in this study. Since only the heads were available, it was not possible to confirm the patients' overall size or body mass but all of the heads were of similar size and came from a number of similarly proportioned breeds (10 greyhound, 3 border collie and 4 mixed breed). It was estimated that the animals were of 15 – 25 kg body mass. Both nerve block techniques were used on each head, one on the right and one on the left. The left and right sided application of the techniques was alternated between heads following random assignment, by coin toss, before injections were performed in the first head. All dye injections were performed by the same final year veterinary student (JJAW), who was equally inexperienced with both techniques. Instruction utilised an additional cadaver head following explanation and demonstration of the relevant anatomy using a canine skull. Following injection the heads were dissected to reveal the maxillary nerve and the length of nerve stained was measured using a ruler marked in millimetres.

A 23 gauge, 1 inch hypodermic needle (Monoject, Coviden, USA) and 2 mL syringe (BD Plastipak, BD, UK) was used to inject 1 mL of methylene blue dye (Proveblue 5 mg ml^{-1}, Provepharm SAS, France) by each technique. For the traditional percutaneous technique a method described in a standard text was used (Dugdale 2010). The needle was inserted through the skin, directed medially and slightly rostrally, just below the ventral border of the zygomatic arch and advanced to its fullest extent or until it could be felt contacting bone. The dye was injected with the needle in this position. The transorbital approach (Fig. 1) to the maxillary nerve block was performed by retropulsing the globe within the orbit by pressing on the upper eyelid. The needle was inserted, directed ventrally, through the conjunctiva approximately 5 mm lateral of the medial canthus and advanced until it could be felt contacting bone, this contact was with the wall of the ptyerigopalatine fossa. The injection was made with the needle in this location.

A power calculation was performed using Minitab 15 (Minitab Ltd, UK) using the data published from a similar study (Viscasillas et al. 2013). It was considered that in order for any difference in the proportion of nerves stained by 6 mm or more between the techniques to be clinically significant it should be greater than the difference reported between the two techniques (traditional and infraorbital approaches) in that study. To detect a proportion of nerves stained by the transorbital technique greater than the 64.9% stained with the modified infraorbital approach of Viscasillas et al. (2013) with a significance level of 5% and power of 82%, a sample size of 16 nerves per group was necessary.

Statistical analysis was performed using GraphPad Prism (GraphPad Software, CA, USA). Following normality testing with the D'Agostino-Pearson omnibus test a paired student's t test or Fisher's exact test were performed as appropriate. Differences between techniques were considered significant when $p < 0.05$. Results are presented as mean ± standard deviation (SD).

Results

Successful staining occurred in 15 out of 17 (88.2%) nerves following the transorbital approach and 14 out of 17 (82.3%) nerves following the traditional percutaneous approach. Whenever the nerve was stained the length of nerve stained was sufficient to produce an effective nerve block (i.e. stained for greater than 6 mm in length). The difference between techniques was not statistically significant ($p = 0.67$). The mean length of nerve stained following the traditional and transorbital techniques was 33 ± 18 and 27 ± 19 mm respectively, again the difference was not statistically significant ($p = 0.26$).

Two nerves were not stained following the transorbital technique, in one case the dye was found in the oral cavity ventral to the orbit, whilst in the other the dye was found in the muscles surrounding the nerve. The three failures to stain following the traditional technique also resulted in the dye being deposited in these muscles.

Discussion

The results of this study suggest that the transorbital approach to the maxillary nerve to be no less effective at delivering dye to the nerve than the traditional percutaneous technique. When compared with the results of an earlier study (Viscasillas et al. 2013) the transorbital approach resulted in a larger proportion of nerves stained for greater than 6 mm than the previously described modified infraorbital approach (88.2% transorbital vs 64.9% modified infraorbital).

This is, however, an unfair comparison as a larger proportion of nerves injected using the traditional percutaneous technique were stained for greater than 6 mm as well (82.3% in this study vs 21.6% reported by Viscasillas et al (2013)). The difference in apparent success using the traditional percutaneous technique between the studies is almost certainly an effect of volume of dye injected. Viscasillas et al. (2013) injected 0.5 mL of methylene blue by each of their techniques, as opposed to the 1 mL injected by each of the techniques in this study. The volume of dye used in this study was selected to model a typical volume used clinically in patients of this size based upon proven efficacy in clinical studies (Cremer et al. 2013) and recommended by standard texts (Skarda & Tranquilli 2007; Clarke et al. 2014). The larger number of heads used in the earlier study (37 vs 17 in this study) may also have influenced the proportions of nerves stained, further confounding this comparison between studies. The number of heads used in this study was based on the sample size identified by the power calculation and determined by the availability of cadaver material.

In many ways discussion of the differences between these studies may be considered irrelevant. When interpreted together in terms of clinical significance, the studies show that the three techniques (modified infraorbital with 0.5 mL, transorbital and traditional percutaneous with 1 mL) can deliver dye to the maxillary nerve covering sufficient distance to create an effective nerve block (i.e. a minimum of 6 mm). Potentially other factors, not assessed by these studies, may influence the chances of achieving a successful block and the adverse effects experienced. These are likely to vary between the techniques and my result in clinically significant differences between them.

The obvious limitations of this study are the direct result of its nature as a cadaver study. Interpretation of staining with methylene blue to simulate the spread of local anaesthetic agents should be approached with caution. Wide variation has been reported between the volumes required to achieve similar distribution of methylene blue and radiographic contrast medium in cadaver studies and local anaesthetic drug to achieve clinical effect in live animals (Bardell et al. 2010). This variation is potentially due to the inherent differences in the physical properties of these liquids e.g. viscosity.

The individual preforming the nerve blocks was inexperienced with both the traditional and the transorbital techniques. The success demonstrated with both of these techniques supports the notion that both are easily learned and have considerable potential for success, even for the relative novice. Comparison of this inexperienced operator with a more experienced individual would have been interesting but would have required more cadaver heads than were available.

Despite the best intentions of the design, this study was unfortunately underpowered for the magnitude of the difference it detected, due to the greater than predicted success of the traditional percutaneous technique. This will have been influenced by the use of a larger dye volume than the study upon which the power calculation was based. A much larger study would be required to confirm that there is no significant difference between the transorbital and traditional percutaneous techniques. Cadaveric material is a scarce resource in many institutions. While a larger scale replication of this study would provide statistical certainty, there may be better ways to use the available material. For example, a comparison with the infraorbital approach described by Viscasillas et al (2013) or an exploration of inter-operator variability.

There were a few disadvantages of the transorbital technique identified during the course of this study that warrant discussion. Firstly, the technique itself can be daunting to the anaesthetist and to observers inexperienced with it. Thorough explanation and demonstration with the assistance of visual aids, for example a canine skull, is often helpful in assuaging any concerns. There is the potential to damage the structures of the eye, both the globe and peri-ocular tissues, the risk is minimised by proper retropulsion of the globe and keeping the needle close to the inner surface of the orbit during advancement. Compression of the globe during retropulsion may trigger the occulocardiac reflex, causing a decrease in heart rate (Turner Giannico et al. 2014) and will increase intraocular pressure. As a result the transorbital technique should probably avoided in patients with a fragile or “open” globe or with elevated intraocular pressure.

There is also a risk of intravascular and intraneural injection of local anaesthetic drugs when using the transorbital approach to the maxillary nerve block. These factors however are not unique to this technique and have potential to occur when performing any nerve block. As with all perineural infiltrative techniques the risk of intravascular injection should be minimised by briefly applying negative pressure to the syringe and confirmation of the absence of blood before injecting the local anaesthetic. The risk of perineural injection is potentially no different between the transorbital and traditional percutaneous approaches to the maxillary nerve block since they target the same anatomical location, albeit from different directions.

This study has demonstrated that the transorbital approach to the maxillary nerve is a viable alternative to the traditional percutaneous technique. In order to definitively demonstrate the potential complications, their sequalae and the clinical efficacy of the technique, a live animal study is required. A direct comparison between the transorbital approach and the modified infraorbital technique of Viscasillas et al. (2013) would also be revealing, as would exploration of the minimum effective dose of local anaesthetic required to achieve an effective nerve block using the various techniques.

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Authors’ contributions

SDL: conception, study design, data interpretation and manuscript preparation; JJAW: data collection, statistical analysis, data interpretation and manuscript preparation.

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Figure Legend

Figure 1 The technique (a) and anatomy (b) of the transorbital approach to the maxillary nerve block. The globe is retropulsed within the orbit and the needle inserted, directed ventrally, through the conjunctiva approximately 5 mm lateral of the medial canthus